

TESTING THE WATERS

Is drug pollution harming the health of people and wildlife?

By Kirsten Weir

Ashley Mulroy eyes a beaker of water taken from a river near her home in Moundsville, W. Va. Her tests found low levels of three antibiotics in the water.

Winning an international award for water-science research at age 17 was good news for Ashley Mulroy. The results of that research were not so good for anyone concerned about the country's waterways and drinking water.

Ashley had read an article about traces of drugs found in European waters and decided to look for *antibiotics* in the tap water of her hometown of Moundsville, W. Va., and in the nearby Ohio River. Antibiotics are drugs prescribed for bacterial infections. Mulroy tested the waters for three common antibiotics: penicillin, tetracycline, and vancomycin. She found trace amounts of all three.

Ashley's findings have a lot of support. Other researchers have found small amounts of almost

every drug imaginable—everything from heart medications to steroids to cold medicines—in waters around the world. Scientists are just beginning to understand the effects that those drugs might have on the environment and on human health.

"This is something that occurs everywhere that people live and take medications and use personal care products," said Christian Daughton, chief of the Environmental Chemistry Branch at the U.S. Environmental Protection Agency's National Exposure Research Laboratory in Las Vegas.

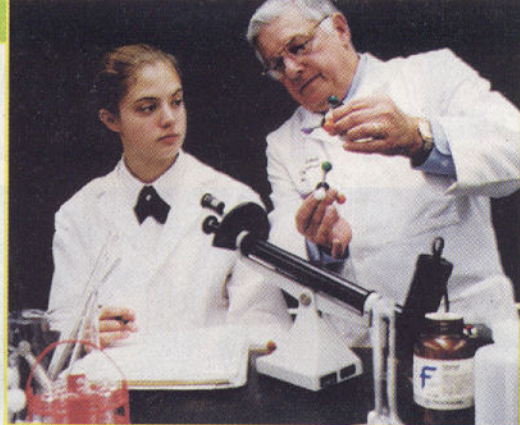
FLUSHED OUT

How do drugs wind up in the water? When people take medications, their bodies excrete the active chemicals in the drugs through urine and feces. As much as 90 percent of an ingested drug leaves the body in a still potent

form and makes its way into the sewage system.

Sewage treatment plants remove solid waste from sewage and *disinfect* the remaining water—kill infection-causing organisms. However, today's treatment plants are not equipped to remove or even detect many *synthetic* (human-made) chemicals in water. Upgrading the nation's treatment plants to remove drugs would cost many billions of dollars, says Daughton.

Healthy farm animals are also given drugs—mostly antibiotics, to keep them from getting sick, and hormones, to make them grow quickly and become more fertile. In 2001, the Union of Concerned Scientists estimated that 26.6 million pounds of antibiotics were fed to animals. So farm waste contains additional drugs that are washed from fields into rivers and streams.



Ashley Mulroy's high school mentor, John Bisbocci, said, "Ashley is my Tiger Woods. She's a teacher's dream—a natural."

In her study of the Ohio River, Ashley found the highest concentrations of antibiotics near farms.

DRUG RESISTANCE

Scientists worry that antibiotics in the environment may contribute to the spread of *bacterial resistance*. Some bacteria are naturally resistant to the effects of antibiotics; others aren't. When antibiotics kill off the vulnerable bacteria, the resistant ones flourish—and pass on their resistance to other bacteria. Scientists are concerned that antibiotic pollution will create large populations of resistant bacteria.

Fortunately, no one has found evidence that the low levels of antibiotics detected in most lakes and rivers lead to the growth of resistant bacteria. But extremely low concentrations of other drugs do affect at least some aquatic organisms.

James Levitt of the University of Minnesota compared populations of walleye pike living in two regions of the Mississippi River, one upstream and one downstream from a lock. Upstream, the water was relatively clean and Levitt found normal wall-

The roach fish, illustrated below, lives in hormone-contaminated rivers in Great Britain. Many males have developed eggs and female reproductive organs.



eye swimming there.

Downstream, the water was contaminated with synthetic hormones called *endocrine mimic-molecules*. The male fish had *testes*, or male reproductive organs, that were malformed and produced no sperm. The females had degenerated *ovaries*, or female reproductive organs.

A government study in Great Britain had similar findings. Researchers studied roach fish in ten rivers over five years and found that just under half of the male fish had developed eggs or female reproductive ducts. The cause? Synthetic *estrogen*, a female hormone, in the water.


Other studies suggest that reptiles and amphibians are also affected by synthetic hormones in their habitats. And laboratory research has shown that antidepressants, such as Prozac, make shellfish *spawn*, or lay eggs, too early or too late, affecting the number of young that survive.

DON'T PANIC

Other drugs, as well as chemicals from perfumes, cosmetics, and cleaning products, make their way down the drain into our waterways. Their impact on human and environmental health isn't well understood.

Scientists also don't know what the cumulative effect of exposure to low levels of many different drugs at once might be. Low doses of one drug could be harmless, but can the same be said for the combined effect of 10 or 20 drugs? "Can concentrations add up to give a larger total concentration?" asked Daughton. "We don't have the wherewithal to tease apart what chemicals are responsible for what effects."

Until those effects can be identified, there is no reason for panic. "I don't think anyone needs to be scared," said Daughton.

Scientists, however, must take a hard look at drug pollution, he says. "People need to realize," he added, "how closely connected they are with the environment." 

DRUGS DOWN THE DRAIN



The active chemicals in the prescription drugs that we ingest...



Leave our bodies through urine and feces...

and make their way through sewage treatment plants, which are not designed to remove the chemicals from wastewater.



The drugs pass into waterways...

and end up back in our drinking water.



Current Science



TEACHER'S GUIDE

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THIS ISSUE AT A GLANCE

Earth Science

Red Menace?

Pages 4-5

Objectives

U.S. researchers are studying dust devils in the Arizona desert to help NASA prepare its first manned mission to the dusty planet of Mars.

Critical Thinking

- What other dangers might dust devils on Mars pose to astronauts?
- How do dust devils differ from tornadoes, waterspouts, and hurricanes?

National Science Education Standard

- *Energy in the Earth system:* convection in the atmosphere
- *Earth in the solar system:* Mars

Internet Links

- *SpaceDaily: Dust Devils at Arizona Targeted for Mars Experiment This Week:* <http://www.spacedaily.com/news/mars-atmosphere-01a.html>
- *Matador Dust Devil Project:* <http://www.lpl.arizona.edu/IMP/Matador/intro.html>

Health Science

Pretty Poison

Pages 6-7

Objectives

The popular vanity drug Botox has medical applications, including the relief of pain and excessive sweating.

Critical Thinking

- How else might doctors put Botox to good use?
- What other natural poisons are used in medicine?

National Science Education Standards

- *Structure and function in living systems:* the skin; the nervous system
- *Diversity and adaptations of organisms:* bacteria

Internet Links

- *Botox: Frequently Asked Questions:* <http://www.botox.com/index.jsp?cc&faq>
- *Newsweek: The Botox Boom:* <http://www.caryskincenter.com/aesthetic/as/botox/The%20Botox%20Boom.htm>

Physical Science

Sweet Freeze

Pages 8-9

Objectives

Food chemists are learning how best to control the size and quantity of ice in cream.

Critical Thinking

- How else might the freezing/melting point of water be lowered to help humankind?
- Is it possible to raise, instead of lower, the freezing/melting point of water? If so, how is it done?

National Science Education Standards

- *Transfer of energy:* heat
- *Structure and properties of matter:* solids, liquids, and gases; crystalline solids

Internet Link

- *University of Guelph: Ice Cream:* <http://www.foodsci.uoguelph.ca/dairyedu/icecream.html>
- *bbc.com: Future Flavours:* http://www.bbc.co.uk/science/tw/items/011114_future_flavours.shtml

Life Science

Testing the Waters

Pages 10-11

Objectives

Earth's waterways are contaminated by trace amounts of prescription drugs. What threat does this pose to the health of people and wildlife?

Critical Thinking

- How might drugs be redesigned so that they don't pollute Earth's waterways?
- If scientists conclude that drug pollution is a significant threat to the health of people and wildlife, how should the United States respond?

National Science Education Standards

- *Environmental quality:* pollution
- *Natural and human-induced hazards:* waste disposal

Internet Link

- *EPA: PPcPs as Environmental Pollutants:* <http://www.epa.gov/nerlesd1/chemistry/pharma/index.htm>

Coming Next Issue

Operation Smile: Nurse Cindi Raglin volunteers to bring surgeries and smiles to kids in the developing world who have facial deformities.

All About Bots: Helen Greiner, president of iRobot, is developing artificial intelligence to get robots into the hands of everyday users.

Whale Talk: Alexandra Morton has spent nearly 20 years learning the language of killer whales in a bay in western Canada.

SKILLBUILDERS

Tests of science knowledge

Turn the page ➤



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